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The energy transfer based fluorescent approach to detect the formation of silica supported phosphatidylcholine and phosphatidylserine containing bilayers

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ABSTRACT

The work introduces the quenching of silica coated Tb(III) complexes by merocyanine 540 (MC540) a copper ions as a tool to reveal the adsorption of phosphatidylcholine (PC) and phosphatidylserine (at various PS:PC ratio onto silica nanoparticles doped with Tb(III) complex. The binding of MC540 w PC-based bilayers and copper ions with PS-based ones are the basis of their use as organic and inorga probes to sense PS:PC ratio in silica supported mixed bilayers. The enrichment of mixed bilayers PS results in the displacement of MC540 anions, while it enhances the binding with copper ions. T displacement or binding of probe ions results in the diverse luminescence response of Tb(III)-centr luminescence. The reestablishment of the steady state and time resolved luminescence is observed, wh MC540 anions are applied as probes. The use of copper ions as probes results in the opposite quench effect. The developed route enables to discriminate the formation of the phospholipids bilayers onto sil surface from those in the bulk of solution under various concentration conditions.

1. Introduction

The aggregates of phospholipids (PhLs) have gained a great interest in recent decades as potential drug delivery systems [1–3], as capsules for hazardous luminescent or magnetic nanoparticles [4–7] and for mimicking the cell membrane properties [8–14]. The PhLs bilayers deposited onto silica beads or so-called supported lipid bilayers (SLB) [8–10] are of great importance for both mimicking processes taking part in cell membranes [13] or in growing the blood compatibility of nanomaterial for imaging and drug delivery [11,12]. The widespread application of SLB as mimics of cell membranes prompts great number of works concerning the regularities and conditions of their formation onto silica nanoparticles [14–20]. A number of methods have been applied to probe into the formation of SLB. The electrokinetic potential, surface pressure and adsorption isotherm measurements, atomic force microscopy, Cryo TEM imaging and contact angle measurements are applied to highlight both driving forces and optimal conditions of the SLB formation [14–20]. Nevertheless the development of the procedure to sense the deposition of various PhLs bilayers onto silica beads is rather appealing task. The present work is inspired by idea to apply donor → acceptor energy transfer as a basis of no methodological approach to sense a formation of SLBs and to g deeper insight into their binding and inclusion capacities. Our p vious works highlight the effect of the adsorption and aggregati of cationic surfactants at the silica/water interface on the ener transfer from Tb(III) complexes coated by silica to the quenchi molecules [21,22]. This procedure is based on the switching fr the significant quenching of Tb(III)-centred luminescence wh quenching molecules are located at the interface of Tb(III)-dop silica nanoparticles (SNs) to the reestablishment of the lumin cence through the displacement of quenching molecules from t interface to the bulk of solution. The present work introduc Tb(III)-doped luminescent SNs as luminescent templates for t adsorption of PhLs and the energy transfer from Tb(III) to ener acceptors at the silica/water interface as the tool to reveal t deposition of PhLs bilayers onto SNs. The silica supported mix bilayers based on zwitter-ionic phosphatidylcholine (PC, Scheme and anionic phosphatidylserine (PS, Scheme 1) are of particu importance due to the mimicking of the cell apoptosis [23,24]. T works [16,17,25,26] highlight the enhanced affinity of cationic a zwitter-ionic phospholipids to negatively charged SNs. The cho of dye anions as quenchers of Tb(III)-centred luminescence is co ditioned by the energy transfer from $^5D_4$ of Tb(III) to the low

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